

## Multislice computed tomography evaluation of lateral orbital wall and sphenoid trigone in Turkey

Evaluation of lateral orbital wall and sphenoid trigone

Hatice Kaplanoglu, Baki Hekimoglu  
Department of Radiology, Diskapi Yildirim Beyazit Research and Training Hospital, Ankara, Turkiye

### Abstract

**Aim:** In this study, we aim to investigate the anterior-posterior length of the lateral orbital wall, and the width and thickness of the posterior base of the sphenoid trigone using multislice computed tomography (MSCT). **Material and Method:** The lateral orbital distance was found by measuring the distance that starts from the axial lateral orbital rim to the point where the lateral rectus muscle contacted the bone. The lateral wall width was measured at the superior border of the lateral rectus muscle. The sphenoid trigone thickness was measured at the level passing through the superior border of the lateral rectus muscle. **Results:** In the right eye, orbital lateral wall length was 21.6 mm, trigone thickness was 13.0 mm, and lateral wall width was 13.0 mm, while in the left eye, the orbital lateral wall length was 20.7 mm, trigone thickness was 9.5 mm, and the lateral wall width was 13.4 mm. **Discussion:** In this study we measured both the mean width and length of the larger part of the sphenoid, and the trigone thickness. These measurements can be used as an anatomical guide in the deep lateral orbital decompression surgery.

### Keywords

Deep Lateral Orbital Wall; Orbital Decompression; Graves' Ophthalmopathy

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Corresponding Author: Hatice Kaplanoglu, Department of Radiology, Diskapi Yildirim Beyazit Training and Research Hospital, TR-06100 Ankara, Turkiye.  
T.: +90 3125084443 F.: +90 31231866 E-Mail: hatice.altinkaynak@yahoo.com.tr  
ORCID ID: 0000-0003-1874-8167

Introduction

Deep lateral orbital wall (LOW) decompression is the most effective decompression type for Graves’ ophthalmopathy that is also associated with the least complications. LOW decompression could sometimes be combined with medial orbital wall decompression [1]. The occurrence of postoperative strabismus following the procedure is particularly very low [2, 3]. The anatomic basis of the procedure was developed by Goldberg et al. who divided the LOW into three parts as follows: lacrimal keyhole, orbital door jamb, and basin of the inferior orbital fissure. The capacity and features of each of these parts have been shown in detail. Thus, they have made it possible to predict postoperative decompression effects [4]. Beden et al. reported additional anatomic findings concerning the deep LOW, by measuring some of the distances and widths of the deep LOW in a medial position of 45° on the nasal bridge [5]. Although there are many articles on deep LOW decompression, the actual appearance and width of the posterior border have not been clearly demonstrated [1]. Anatomic variations among the patients have also been reported to be very common [6]. Anatomic variations in vital organs, such as the middle cranial fossa, make lateral wall decompression more difficult. The use of this procedure is limited particularly due to the surgeons’ lack of experience regarding its application, and their concerns about cerebrospinal fluid (CSF) leak and the possible exposure of dura [7, 8].

In this study, we sought to investigate the anterior-posterior length of the LOW, and the width and thickness of the posterior base of the sphenoid trigone by multislice computed tomography (MSCT).

Material and Method

In the present study, orbital CT images of the 110 patients, who were referred to the radiology clinic for non-emergency reasons between January 1, 2017, and December 30, 2017, were evaluated retrospectively. All orbital CT images were obtained using the MDCT device at the radiology center (GE Optima 660 SE 64 Detector 128-slice CT, General Electric Medical Systems, Milwaukee, WI). The scanning parameters were as follows: 120 kW; 110mA; rotation time was 0.5 minutes; 0.625 mm section thickness; pitch ratio was 1.375 mm; detector coverage was 4 cm and field of view was 25 cm. Section thickness of the standard coronal and sagittal reformatted images was 0.625 mm. Patients who had bilateral normal orbits were included in this study. Patients who had past orbital fascial surgery history; patients with the orbital disease, such as orbital tumor, orbital cellulite, orbital wall fracture, and Graves ophthalmopathy; individuals with acute dacryocystitis; patients who had asymmetric filming; and patients under 18 years of age were excluded from this study.

The longest section of the lateral rectus muscle in the axial section and the thickest section of the lateral orbital bone in the coronal section was selected. The lateral orbital distance was found by measuring the distance that starts from the axial lateral orbital rim to the point where the lateral rectus muscle contacted bone (Image 1). The lateral wall width was measured at the superior border of the lateral rectus muscle in the thickest part of the lateral orbital bone in the coronal section (Image

2). The sphenoid trigone thickness was measured at the level passing through the superior border of the lateral rectus muscle, specifically through the axial section of the coronal section where the lateral wall width was measured (Image 3).

The study was approved by the Clinical Trials Ethics Committee before initiation and conducted in accordance with the principles of the Declaration of Helsinki.

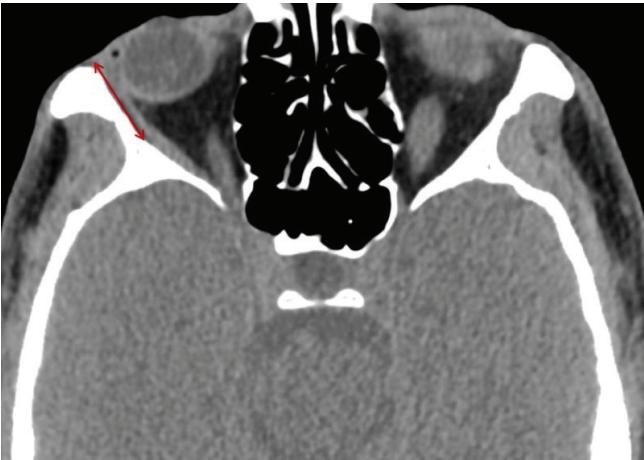


Figure 1. Measurement was performed to determine the distance that started from the axial lateral orbital rim to the point where the lateral rectus muscle contacted the bone.

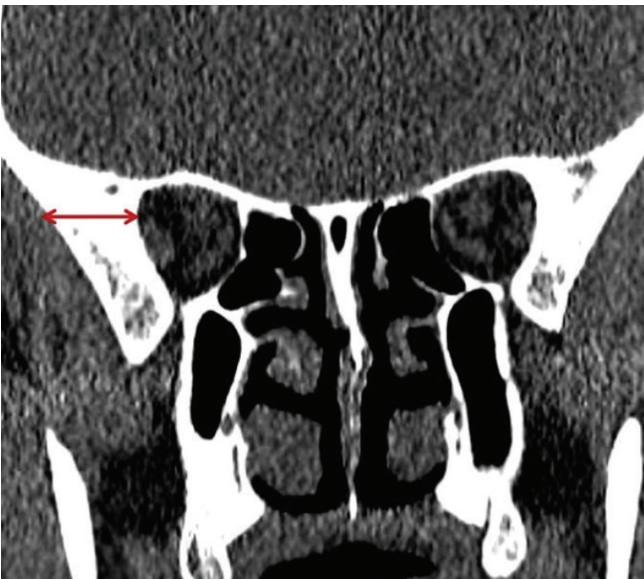


Figure 2. The thickest part of the lateral orbital bone in the coronal section was measured over the superior border of the lateral rectus muscle.

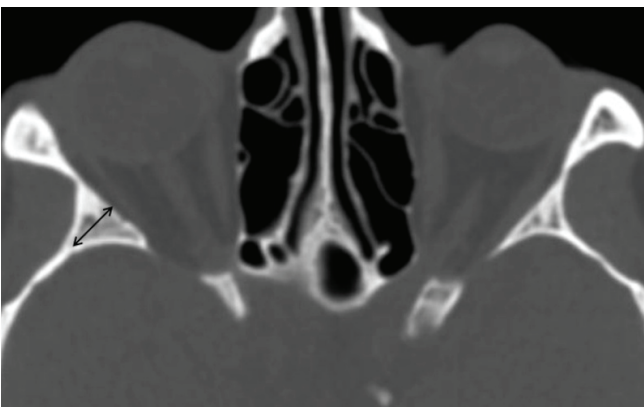


Figure 3. The sphenoid trigone thickness was measured at the level passing through the superior border of the lateral rectus muscle.

Statistical Analysis

Statistical analysis was performed and evaluated using SPSS version 22.0 software (SPSS Inc, Chicago, IL). Descriptive statistics were expressed as mean ± standard deviation (minimum-maximum), frequency distribution and percentages. The variables were tested for conformity to the normal distribution using visual (histogram and probability graphs) and analytic methods (Kolmogorov-Smirnov Test), and all variables were found to lack normal distribution. The Mann-Whitney U test was used for evaluating statistical significance between two independent groups, and the Wilcoxon Signed Rank Test was used for evaluating statistical significance between two dependent groups. A *p*-value of <0.05 was considered statistically significant.

Results

A total of 110 patients were included in our study, 50% of which were male (*n* = 55) and 50% were female. The mean age of the patients was 40.3 ± 14.5 (17-70) years. In the right eye, orbital lateral wall length was 21.6 mm; trigone thickness was 13.0 mm, lateral wall width was 13.0 mm, while in the left eye, the orbital lateral wall length was 20.7 mm, trigone thickness was 9.5 mm, and the lateral wall width was 13.4 mm. The lateral wall length of the right eye was found to be significantly higher than the left eye (*p*<0.001), whereas right eye lateral wall thickness was longer (*p*<0.001). Regarding trigone thickness, no statistically significant difference was observed between the right and left eyes (*p*=0.448) (**Table 1**). In female patients, lateral wall length and trigone thickness of the right eye was found to be higher than of the left eye (*p*=0.006; *p*=0.008, respectively) and the lateral wall thickness of the right eye was found to be lower (*p*<0.001) (**Table 2**). Left eye trigone thickness of the male patients was observed to be higher than female patients (*p*=0.020). No difference was observed between male and female patients in all other orbital measurements (*p*>0.05) (**Table 3**).

Discussion

The lateral orbital wall has become a preferred area for orbital decompression [9]. Inferomedial decompression has significant risks for consecutive diplopia and globe displacement [10]. Chronic sinusitis may occur when sinuses are disrupted, and particularly when the osteomeatal complex is affected [10]. Dura on the fovea ethmoidalis cannot be easily visualized, and its laceration may result in intracranial bleeding or chronic CSF leakage. The risk of diplopia induced by lateral decompression is lower since the muscle cone cannot change its position inferomedially. Through lateral orbital decompression, backward displacement by at least 6 mm in the globe and 5 cm<sup>3</sup> loss of bone volume is possible [10]. In traditional surgery, anterior LOW of the patient is removed, and the degree of orbital expansion that could be obtained is limited [11]. After removing the thick deep parts of the lateral wall, a significant cavity is created for orbital expansion [11]. It is difficult to directly observe the appearance of the posterior border during surgery since deep LOW bone marrow is rigid in living bodies [1, 12]. Obtaining information about the position and width of the posterior border of the deep LOW is useful for understanding the actual anatomy [1]. Due to this information, surgeons can achieve

better planned and more precise results.

Trigone, which is referred to as the orbital doorcase by Goldberg et al. [9] allows the orbital to expand substantially both in the lateral and posterior directions. Beden et al. measured the trigone volume and height using CT, and have identified two segments. The first segment starts from the base of the trigone and extends to the superior border of the lateral rectus

Table 1. Distribution of the right and left orbital measurements

(n=110)	Right Eye	Left Eye	<i>p</i> *
	Mean ± SD (min-max)	Mean ± SD (min-max)	
Lateral Wall Length (mm)	21.6 ± 3.0 (15.8-32.4)	20.7 ± 3.4 (2.4-30.4)	<0.001
Trigone Thickness (mm)	9.8 ± 3.0 (3.5-19.7)	9.5 ± 2.8 (4.6-21.1)	0.448
Lateral Wall Width (mm)	13.0 ± 2.1 (7.5-18.4)	13.4 ± 2.4 (1.2-21.6)	<0.001

\*Wilcoxon Signed-Rank Test

Table 2. Distribution of the right and left orbital measurements according to the sex

(n=110)	Right Eye	Left Eye	p*
	Mean ± SD (min-max)	Mean ± SD (min-max)	
Male (n=55)			
Lateral Wall Length (mm)	21.9 ± 3.3 (15.8-32.4)	21.1 ± 3.4 (10.0-30.4)	0.002
Trigone Thickness (mm)	9.7 ± 2.9 (5.5-17.9)	10.1 ± 2.8 (5.5-18.5)	0.114
Lateral Wall Width (mm)	13.1 ± 2.0 (7.5-17.5)	13.1 ± 2.6 (1.2-18.5)	0.233
Female (n=55)			
Lateral Wall Length (mm)	21.4 ± 2.6 (17.1-29.1)	20.4 ± 3.4 (2.4-29.3)	0.006
Trigone Thickness (mm)	9.8 ± 3.3 (3.5-19.7)	8.9 ± 2.6 (4.6-21.1)	0.008
Lateral Wall Width (mm)	13.0 ± 2.1 (8.9-18.4)	13.7 ± 2.0 (10.2-21.6)	<0.001

\*Wilcoxon Signed-Rank Test

Table 3. Distribution of the orbital measurements between males and females

	Male (n=55)	Female (n=55)	p*
	Mean ± SD (min-max)	Mean ± SD (min-max)	
Right Eye			
Lateral Wall Length (mm)	21.9 ± 3.3 (15.8-32.4)	21.4 ± 2.6 (17.1-29.1)	0.379
Trigone Thickness (mm)	9.7 ± 2.9 (5.5-17.9)	9.8 ± 3.3 (3.5-19.7)	0.707
Lateral Wall Width (mm)	13.1 ± 2.0 (7.5-17.5)	13.0 ± 2.1 (8.9-18.4)	0.937
Left Eye			
Lateral Wall Length (mm)	21.1 ± 3.4 (10.0-30.4)	20.4 ± 3.4 (2.4-29.3)	0.381
Trigone Thickness (mm)	10.1 ± 2.8 (5.5-18.5)	8.9 ± 2.6 (4.6-21.1)	0.020
Lateral Wall Width (mm)	13.1 ± 2.6 (1.2-18.5)	13.7 ± 2.0 (10.2-21.6)	0.343
Average of Right and Left Eyes			
Lateral Wall Length (mm)	21.5 ± 3.2 (14.8-28.9)	20.9 ± 2.6 (12.6-28.7)	0.421
Trigone Thickness (mm)	9.9 ± 2.5 (5.7-18.2)	9.4 ± 2.8 (4.3-20.4)	0.301
Lateral Wall Width (mm)	13.1 ± 2.2 (6.6-17.7)	13.4 ± 2.0 (9.6-20.0)	0.757

Mann-Whitney U Test

muscle, where the trigone is found to have the least thickness before it starts to become thicker again. The second segment starts from the superior border of the lateral rectus, extends superolaterally to the junction of the roof and the lateral wall of the orbit [5]. Thus, in our study, lateral rectus muscles were determined as a marker in both axial and coronal images during the CT evaluation.

Anthropometric studies of the anatomy of orbit have revealed significant variations among individuals. Considerable differences have been reported not only between individuals but also between the right and left sides. For example, in a study by Lefebvre et al. [13], the left sphenoid trigone was found to be larger than the right sphenoid trigone during the intrasubject paired analysis. In the present study, no difference was observed between the right and left eyes regarding trigone thickness.

In Turkey, Beden et al. [5] directly measured 18 skulls and reported a lateral wall width of 13.0 mm, and a distance from orbital rim to trigone of 23.3 mm. In a study (2008) of 27 post-mortem orbits of 17 Asian patients, Kakizaki et al. [1] measured the width of the posterior border and the distance from orbital rim to the posterior border. Posterior border width of the LOW was reported as 17.6 mm on the right and as 17.3 mm on the left. The mean distance from orbital rim to the posterior border was reported as 32.9 mm on the right and as 32.7 mm on the left. The width of the posterior border of the deep LOW remained almost the same at different levels. However, in the study of Beden et al. the distance from lateral orbital rim to the deep LOW and the LOW thickness were found to vary at different levels [5]. In particular, as the levels move towards the cranial, the distance and thickness values were observed to be lower [1]. Hence, Beden et al. suggested that the bone milling operation should be started from the thickest inferior part of the deep LOW [1, 5].

In a study on 334 Korean orbits, Lee et al. [14] measured deep LOW and sphenoid trigone using CT analysis. The mean anterior-posterior length of the lateral wall was found to be 26.0 mm on the right, and 25.0 mm on the left; the mean width of the posterior base of the sphenoid trigone was measured to be 16.0 mm on the right, and 16.2 mm on the left. No statistically significant difference was observed between the age groups and between the two sides [14]. In the present study, the anterior-posterior length of the lateral wall was found to be 21.6 mm on the right, and 20.7 mm on the left; the mean width of the posterior base of the sphenoid trigone was measured to be 13.0 mm on the right, and 13.4 mm on the left. The difference between the measurements is thought to arise from different environmental and racial characteristics.

Determining the lateral wall width is an important marker for understanding the position of the lateral wall when it is being grinded intraoperatively. Bone extraction should be stopped when the base width becomes closer to the posterior border width [14]. In the present study, we measured the thickest part of the LOW, which is the location where primary extraction is often performed, and the thickness of the trigone. It may serve as an indicator for evaluating the location of the lateral wall. Lateral wall location and appearance can be defined intraoperatively using CT measurements.

## Conclusion

In orbital decompression surgery, patient-specific CT analysis should be included in the surgical planning before the operation. These measurements can serve as standard reference values for the lateral wall, and be used as an anatomical guide in deep lateral orbital decompression surgery. Reference values of the distance and width of the lateral wall, which are specific to age and person, will assist inexperienced surgeons to predict the appropriate depth for lateral wall decompression. This will help prevent any unexpected entry into the anterior or middle cranial fossa and possible dural damage.

## Scientific Responsibility Statement

*The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.*

## Animal and human rights statement

*All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.*

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## Conflict of interest

*None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.*

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